TN 295
.U4

IC 8840
1981

IC 8840

Bureau of Mines Information Circular/1981

Dist/Label

BUREAU OF MINES
MAY - 1 1981
COPY
EXCHANGE & GIFT DIVISION

Minerals Health and Safety In-House Research, Development, and Demonstration in Fiscal Year 1981

By Staff, Division of Minerals Health and Safety Technology

UNITED STATES DEPARTMENT OF THE INTERIOR

United States. Bureau of Mines.

Information Circular 8840

Minerals Health and Safety In-House Research, Development, and Demonstration in Fiscal Year 1981

By Staff, Division of Minerals Health and Safety Technology

UNITED STATES DEPARTMENT OF THE INTERIOR
James G. Watt, Secretary
BUREAU OF MINES

TN295
.U4
IC 8840 1981

This publication has been cataloged as follows:

United States. Bureau of Mines. Division of Minerals Health and Safety Technology

Minerals health and safety in-house research, development, and demonstration in fiscal year 1981.

(Information circular / United States Department of the Interior, Bureau of Mines ; 8840)

1. Mine safety—United States. I. Title. II. Series: Information circular (United States. Bureau of Mines) ; 8840.

TN295.U4 622s [622'.8'0973] 81-1580 AACR2

CONTENTS

	Page
Abstract	1
Introduction	1
Program outline	2
Health	3
Respirable dust	3
Control of dust formation	3
Control of generated dust	3
Dust instrumentation and measurement	4
Radiation hazards	5
Fundamental studies	5
Control of radiation hazards	5
Test facilities	6
Noise control	6
Industrial hygiene	7
Toxic gases and materials	7
Diesel engines and alternative power sources	8
Ventilation	8
Safety	9
Fires and explosion prevention	9
Prevention research	9
Ignition research	9
Suppression research	10
Propagation research	10
Extinguishment research	11
Detection, instrumentation, and alarm	11
Methane control	12
Fundamental factors	12
Control in advance of mining	12
Control during mining	13
Ground control	14
Premining investigations	14
Selection of mining system and mine opening design	15
Roof support system	18
Safe support installation and protection at the face	20
Hazard detection and monitoring systems	21
Mining and minerals processing waste stability	24
Industrial-type hazards	25
Human factors	25
Electrical	25
Equipment	26
Illumination	27
Nonemergency communications	27
Haulage and materials handling	28
Post disaster	29
Survival	29
Communications	29

CONTENTS--Continued

	Page
Explosives	30
Blasting agents and other hazardous chemicals	30
Systems engineering	31
Systems analysis	32
Test facilities	32

MINERALS HEALTH AND SAFETY IN-HOUSE RESEARCH, DEVELOPMENT, AND DEMONSTRATION IN FISCAL YEAR 1981

by

Staff, Division of Minerals Health and Safety Technology

ABSTRACT

This publication summarizes, for all interested parties, the research, development, and demonstration in-house projects programed by the Bureau of Mines for fiscal year 1981 (October 1, 1980 - September 30, 1981) under its Minerals Health and Safety Technology program. The objective of these projects is to provide an ordered and sequenced series of advances toward the Bureau's overall goal of providing the system technology required to create a healthier and safer working environment for the Nation's mining and minerals processing workers.

INTRODUCTION

The Bureau of Mines conducts a balanced, continuing in-house research and development program to accelerate systematic improvements in health and safety conditions in U.S. mines. This paper outlines the Bureau's present in-house effort to all interested parties; in particular, potential contractors can refer to it when submitting USP's (unsolicited proposals), thus avoiding proposing research that duplicates work being performed by the Bureau.

The projects presented were planned at the beginning of the fiscal year and are subject to change based on emerging priorities and availability of funds. Contingencies may require that a significant portion of the program be deferred into fiscal year 1982. A companion publication, Information Circular 8839, lists contract projects.

PROGRAM OUTLINE

The objective of the Minerals Health and Safety Technology program is to protect the health and safety of mining and minerals processing workers while insuring that newly developed technology incorporates health and safety criteria. In achieving this objective, four fundamental and complementary requirements must be considered by the research program, as follows:

1. Contributing to the viability of a basic industry.

2. Sustaining productivity.

3. Allowing for a return on capital investment.

4. Providing material and energy to the public.

Since mining and minerals processing involve a highly integrated and interrelated set of functions, the program has been divided into a set of interrelated subprograms, each with goals that will provide systems technology solutions to the problems within the framework of these fundamental requirements. The Minerals Health and Safety Technology program is divided into 12 subprogram areas as shown:

Health	Safety
Respirable dust	Fires and explosion prevention
Radiation hazards	Methane control
Noise control	Ground control
Industrial hygiene	Industrial-type hazards
Ventilation	Post disaster
	Explosives
	Systems engineering

The objectives of these subprograms are described in the following pages, followed by the planned projects and their corresponding descriptions. The aggregate value of the planned in-house projects is approximately $14 million.

HEALTH

Respirable Dust

Program Objectives: To develop procedures for controlling the respirable dusts that still constitute the severest health problem facing the mining and mineral processing industries. To develop and/or improve techniques and equipment to prevent formation of hazardous dust concentrations, and to protect miners against dusty atmospheres.

Control of Dust Formation

1. Reduction of Airborne Coal Dust With Increased Machine Efficiency

Objective: To develop background information in support of contract research related to reduction of primary dust generation at the bit-coal interface during cutting. To continue to determine the effects of water lubricity at the cutter-coal interface on primary dust generation and cutting forces. To continue bit wear studies and cooperative effort with Sandia Labs to develop new long-wearing cutting bits.

2. Dust Control at the Cutter-Coal Interface

Objective: To define dust generation distribution patterns from rapidly moving cutting bits to evaluate optimum methods for secondary suppression of airborne respirable dust at the generation source.

Control of Generated Dust

3. Control of Respirable Dust by Water Infusion and Other Means of Preconditioning

Objective: To conduct underground evaluations to determine the effectiveness of water infusion for respirable dust control. Particular attention will be given to longwall mining operations in different coal seams. Work will also include evaluation of the physical properties of the coalbeds relating to fracture permeability and porosity.

4. Dust Control by Chemicals and Chemical Additives

Objective: To continue to determine the potential of chemical (binders, salts, evaporative retardants, and surfactants) for reducing dust from underground coal mine roadways. To determine the effectiveness of rock dust with salts and other chemicals for dust control. To continue to evaluate the effectiveness of different wetting agents for different types of coals.

5. Development of Dust Control Technology for Coal Mines

Objective: To conduct preliminary studies of concepts for improvements in dust control technology for coal mines. Primary consideration will be given to the application of shrouded high-pressure sprays and fog nozzles to improve the reliability and associated hardware.

6. Dust Control Technology for Noncoal Mines and Mineral Processing Mills

Objective: To conduct preliminary studies leading to development of improved dust control technology for noncoal mines and mineral processing mills. To investigate dry dust control system for a loading machine. To develop a method of using tracer gas to determine capture efficiencies of various dust collector systems. To continue to evaluate current dust control technologies in silica-processing mills.

7. Survey of Dust Control Problems

Objective: To continue the compilation of respirable dust sources and their control problems for mining and minerals processing operations. To analyze MSHA (Mine Safety and Health Administration) respirable dust data to establish the risks of occupational exposure.

8. Control of Respirable Heavy Metal Dust in Lead Ore Milling Operations

Objective: To identify areas of heavy metal concentrations in respirable dust in typical lead milling environments and identify research necessary to modify existing processes or equipment to reduce personnel exposure to respirable heavy metals.

9. Control of Respirable Dust Associated With Milling of Clays

Objective: To obtain baseline data on clay mining and milling operations as related to health problems associated with respirable dust. To identify potential health problems and conduct research to develop technologies for control of respirable clay dusts.

10. Suppression of Dust in Unconfined Clouds

Objective: To develop a fundamental understanding of the suppression of dust in unconfined clouds by water sprays and provide guidelines for optimizing water sprays for effective control of generated dust.

Dust Instrumentation and Measurement

11. Respirable Dust Measurement Instrumentation Evaluation

Objective: To continue evaluating dust samplers and monitors developed by Bureau contractors and others in the laboratory and in mines. Specific instruments to be evaluated include a prototype light reflectance photometer, light-scattering dust monitors, and various cascade impactors. To seek out new aerosol detection techniques and determine feasibility of applying them to the measurement needs of the mining industry.

12. Characterization of Airborne Coal Dust

Objective: To conduct special analysis of field dust collection filters provided by MSHA and Bureau contractors. To characterize samples and measure the quartz content. To develop analytical procedures for accurate analysis of airborne coal dust.

13. Analytical Methods for Measurement and Characterization of Airborne Particulates

Objective: To develop reliable methods for the qualitative and semiquantitative determination of mercury at mineral processing plants. These methods will be suitable for use by MSHA as well as plant personnel. To conduct special studies as requested by MSHA, which may include the characterization of mineral airborne fibrous particulates.

Radiation Hazards

Program Objectives: To develop and provide new and improved measurement instrumentation and control technology for protection of miners from exposure to radon and radon daughters and other nuclear radiation hazards in uranium and other mines.

Fundamental Studies

1. Study of Underground Uranium Mill Waste Disposal Practices

Objective: To define radiation hazards, possible improved corrective measures, and areas needing further research in uranium milling operations in relation to workers' health. Emphasis will be on underground disposal of the entire uranium mill tailings product.

Control of Radiation Hazards

2. Radon Control Technology

Objective: To continue to develop radon control technology for use in both underground and open pit uranium and other mines by investigating the engineering feasibility and cost effectiveness of using sealants, bulkheads, pressure control, tailings backfill, and moisture control in preventing or reducing radon leakage into the fresh airways. These studies will be exploratory in nature. Evaluations of radon control techniques will be conducted primarily in the laboratory with limited in-mine testing of the most promising methods for the purpose of developing sound engineering guidelines for future full-scale development, in-mine testing, and demonstration.

3. Control of Radiation Hazards Through Air Cleaning

Objective: To continue research on the use of air-cleaning techniques for removal of radon daughters from underground mine atmospheres. To determine efficiencies, filter life with regard to moisture and airborne particle size, and concentration and characteristics of the radioactive components of the filtered air. To provide necessary technical assistance to the contractor during testing phase of a prototype air-cleaning system.

4. Electronic Radon Daughter Personal Dosimeter

Objective: To continue to make necessary modifications based on results of field testing. To verify the adequacy of modifications in the laboratory and field. To develop specifications for hardened version. To continue to explore the feasibility of using a hybrid detector in lieu of the current type.

5. Personal Exposure Instrumentation and Measurement Technology

Objective: To continue laboratory and field studies on instrumentation for exposure measurements and methods of making exposure measurement related to the miner's exposure to nuclear radiation hazards, with emphasis on the measurement of radon daughter products. Areas to be covered include (a) personal dosimeters, (b) area monitors, (c) shift monitors, (d) long-lived radionuclides in mine air, and (e) the uncombined fraction of daughter products in mine air. To begin development and evaluation of gamma ray personal dosimeters. To continue to improve the accuracy and reliability of the current TL dosimeter system.

6. Radiation Warning System for Uranium Mines

Objective: To continue field evaluation of full system at large uranium mining and milling operations. To demonstrate stand-alone detector at smaller operations. To revise software and hardware to reflect improvements suggested by previous field tests. Modifications shall also be added to enable ventilation and other parameter monitoring.

Test Facilities

7. Lease and Operate the Twilight Mine

Objective: To continue to operate and maintain an underground uranium mine as a test facility to provide typical mine environmental conditions for research and development studies conducted by the Bureau of Mines, MSHA, other Government agencies, and outside contractors in the area of radiation hazards.

Noise Control

Program Objectives: To identify noise sources in underground and surface mines and in related mineral cleaning and preparation facilities, and to abate these noise sources sufficiently to meet Federal noise exposure standards.

1. Development of Noise Control Techniques for Coal Mining Machinery

Objective: To further the implementation of noise control techniques to the mining industry. This will be accomplished via equipment development and dissemination of information.

2. Noise Study of Lead and Other Metal-Nonmetal Mining in the Central United States

Objective: To identify work areas in metal and nonmetal mines where noise exposure of personnel is most severe and the need for noise control technology is most urgent.

Industrial Hygiene (Toxic Substances)

Program Objectives: To identify and control health hazards in surface and underground mines and mineral processing plants caused by toxic gases and fumes, and certain particulates produced by explosives, combustible materials, and diesel engines. To develop and evaluate new instrumentation for monitoring these substances. To develop and/or refine analytical techniques for measuring and characterizing toxic substances, and investigate methods for controlling the formation and accumulation of toxic products. To analyze alternative power sources that may have health advantages over existing mine diesels.

Toxic Gases and Material

1. Toxic Fumes From Explosives

Objective: To establish the relationship between toxic fumes produced in a 38,000-liter chamber and those produced in the Bichel Gage and C-J Apparatus and relate these to explosive fumes from in-mine measurements. To carry out fume measurements on all types of mining explosives including blasting agents.

2. Improved Instruments for Mine Gases

Objective: To develop personal exposure monitors such as passive, delayed analysis samplers for NO_2 and NO_x, and dosimeters for CO and NO based on electrochemical or infrared principles. To develop machine-mounted monitors for continuous monitoring of specific air contaminants on mobile equipment.

3. Measurement and Control of Welding Fumes

Objective: To assess related industry practices pertaining to measurement and control of welding and cutting fumes, dust, and radiation, and adapt this technology to confined work areas found in the mining environment. To determine the quantity and character of welding pollutants and personnel exposure levels. To propose control systems and/or isolation techniques to reduce or eliminate exposure to toxic substances resulting from welding and cutting.

4. Evaluation of Industrial Hygiene Instrumentation and Equipment

Objective: To evaluate and verify the performance of commercially available or contract-developed instruments and devices for noxious and toxic gases. To acquire instruments and devices and evaluate their operation under varying conditions of temperature, humidity, and pressure. To determine the stability, accuracy, precision, sensitivity, and applicability to measure noxious and toxic gases in the mining environment.

5. Control of Mercury Vapor Emission in Mercury Ore Processing

Objective: To determine the conditions under which mercury vapor is released during grinding and froth flotation operations, and correlate these conditions with measured levels of vapor emissions. To identify technology to prevent or control mercury vapor emissions during the milling process.

Diesel Engines and Alternative Power Sources

6. Control of Diesel Exhaust Contaminants

Objective: To supplement contract research in the control and analysis of diesel exhaust emissions. To measure ambient contaminants and correlate with emissions data. To investigate control systems for contaminants by means of laboratory experiments. To devise and select analytical procedures for emission control systems and components at the tailpipe and ambient levels.

7. Investigation of Emission Controls for Turbocharged Diesel Engines Operated Underground

Objective: To identify potential methods and hardware applicable for use as emission controls for turbocharged mine diesels. Work will continue to review the literature and monitor the current state of knowledge concerning emission control technology. State and international regulations pertaining to the use of internal combustion engines underground will be delineated. A survey of underground diesel population will be performed with the cooperation of MSHA. Applications of diesel equipment in new mining systems (e.g., oil shale) will be studied. Alternative power sources that may have health and operational advantages over existing mine diesels will be analyzed.

Ventilation

Program Objectives: To develop ventilation systems required to maintain a safe and healthful atmosphere conducive to efficient work output in noncoal mines.

1. Development of Improved Ventilation Technology for Noncoal Mines and Mineral Processing Mills

Objective: To develop improved technologies for ventilating and cooling stopes and development headings in hot metal and nonmetal mines. To develop improved and safe methods of heating shafts in winter in order to prevent ice

buildups and to make the transport of men comfortable. To continue to develop methods of ventilating dead-ended working headings in metal and nonmetal mines.

SAFETY

Fire and Explosion Prevention

Program Objectives: To reduce the potential for fire or explosion in mineral extraction and processing operations; to minimize the danger to people on account of fires or explosions that do occur.

Prevention Research

1. Flammability of Coal Mine Combustibles

Objective: To evaluate flammability hazard of mine combustibles and develop improved test methods to update MSHA fire test standards.

2. Improved Bit Materials for Continuous Coal Mining Machines

Objective: To reduce frictional ignitions, respirable dust, and noise, while also increasing productivity, by improving coal cutter bit materials.

3. Float Dust Formation and Deposition

Objective: To investigate rate of formation of float coal dust, size distributions of coal and rock dusts, and rate of deposition of coal and rock dusts; to field-test a dust deposition meter; and to conduct field investigations and demonstrations of engineering techniques to suppress float coal dust.

4. Pacification of Sulfide Oxidation

Objective: To develop techniques and materials that will pacify the spontaneous combustion of sulfide concentrates that frequently occur during mining and storing.

Ignition Research

5. Bit Impact Ignition of Methane

Objective: To establish operating conditions necessary to reduce the methane ignition probability caused by frictional impact heating during coal cutting.

6. Thermal Ignition of Coal Dust

Objective: To determine mechanism of ignition, combustion, and suppression of coal dust flames.

7. Spontaneous Heating of Coal Mine Combustibles

Objective: To investigate spontaneous heating of U.S. coals and to develop combustion criteria for identifying incipient mine fires.

8. Laboratory Dust Flammability Testing

Objective: To study the flammability of air-dispersed dust in laboratory-scale vessels and to correlate the data with full-scale mine studies.

Suppression Research

9. Prevention and Suppression of Face Ignitions and Explosions

Objective: To develop, test, and conduct field trials of techniques for the prevention and suppression of face ignitions and methane and coal dust explosions.

10. Mechanisms of Flame and Explosion Suppression

Objective: To determine the chemical and physical processes by which gaseous and powdered extinguishing agents suppress flames and coal dust explosions.

11. Improved Mine Fire Protection

Objective: To improve fire safety in underground metal and nonmetal mines by improving early fire warning systems.

12. Improved Fire Protection Hardware Demonstration

Objective: To develop improved fire protection hardware and procedures for mobile mining equipment.

Propagation Research

13. Flame Propagation Into Mine Gob Through Methane Drainage Holes

Objective: To determine the probability and/or conditions under which flame could propagate into a mine through methane-emitting boreholes.

14. Full-Scale Mine Explosion Research

Objective: To increase the understanding and predictability of the initiation, propagation, and suppression of explosions of gases and dust in multientry and longwall coal mines and oil shale mines, with emphasis on full-scale simulation in the Experimental Mine.

15. Fire and Explosion Properties of Oil Shale

Objective: To continue work in the Experimental Mine, to determine the widest limits of explosibility of oil shale dust, as a function of kerogen content,

particle size, and with methane added to the air flow. To conduct controlled rubble fire tests as needed, and to coordinate cooperative projects in the field as opportunities arise.

16. Physical Modeling of Mine Timber Fires

Objective: To develop basic understanding of mine fire hazards and parameters, to develop optimal means of prevention and control of mine fires, and to establish procedures for modeling mine fires using small-scale duct fires.

17. Explosion Testing of Bulkheads

Objective: To develop specifications for strength and water tightness for bulkheads, seals, and retaining coal blocks. To clarify current regulations and to provide a basis for future regulations.

18. Fire and Explosion Hazards of Oil Mining

Objective: To determine the fire and explosion hazards of crude oil in the presence of underground mining operations.

Extinguishment Research

19. Sealed Coal Mine Fires

Objective: To develop needed guidelines for safe reopening of a mine following the sealing of a coal mine fire.

20. Inert Gas Generator for Extinguishment of Mine Fires

Objective: To develop a portable inert gas generator suitable for in-mine extinguishment of coal mine fires.

Detection, Instrumentation, and Alarm

21. Evaluate Detection Systems For Fire and Explosion Prevention

Objective: To develop adequate fire and explosion sensors and guidelines for their optimum deployment for the early warning of mine fires and explosions.

22. Laboratory Raman Scattering Remote Methanometer

Objective: To determine the feasibility of remote methane detection by the principle of Raman scattering, to measure the Raman scattering properties of methane, to quantify the angular distribution of scattered light intensities from methane, and to determine minimum levels of methane that can be detected remotely.

23. Mine (Fire) Ventilation Code, Modification and Maintenance

Objective: To modify and verify mine (fire) ventilation simulation computer program to improve its applicability, usefulness, and acceptability.

24. Microscopic Structure and Composition of Combustible Dusts and Residues

Objective: To develop pre- and post-explosion information about the surface characteristics, size distribution, and compositional distribution of (1) combustible dusts and (2) mixtures of dusts and fire extinguishants.

Methane Control

Program Objectives: To develop, demonstrate, and transfer technology that will prevent the formation of flammable methane-air mixtures in underground mine workings through improved ventilation and procedures for degasifying the deposit or seam in advance of and during mining. To establish correlations between the geology of the material to be mined and its gas content, and to use these to predict methane emission hazards.

Fundamental Factors

1. Prediction of Coalbed Discontinuities To Increase Effectiveness of Drilling for Methane Drainage

Objective: To determine fundamental factors and statistical evaluation techniques that can be used to predict coalbed discontinuities in advance of mining, with particular emphasis on those hazards that may adversely affect degasification projects.

2. Influence of Geology on Occurrence and Emission of Methane in Coal Measures

Objective: To map selected coalbeds and the related geology to determine the gas content of coalbeds and the relationship of geology to mining and methane emission problems, and to assist in selecting sites for degasification of these coalbeds.

3. Investigations of Methane in Metal and Nonmetal Mines

Objective: To establish the origin of methane and other gases associated with rocks in metal and nonmetal mines and the factors influencing the migration of gas into those mines to provide a basis for development of control technologies.

Control in Advance of Mining

4. Use of Large-Diameter Multipurpose Borehole for Methane Control

Objective: To monitor to completion (upon the holes being mined through) the effectiveness of the multipurpose borehole for degasification.

5. Application of Vertical Borehole Degasification to Mine Safety

Objective: To determine the effects of borehole spacing and methods of stimulation on reducing methane gas emissions into active mine workings by demonstrating the feasibility of draining gas from gassy coalbeds through vertical boreholes.

6. Use of Air Shafts for Degasifiction in Advance of Mining

Objective: To demonstrate the utility and cost effectiveness of air shafts sunk in virgin coal areas, with holes drilled in the coalbeds from the bottom of the shafts at least 1,000 feet in depth for degasification about 5 years ahead of nearest mine workings. By planning future air shafts carefully, for more extensive degasification, greater productivity with increased safety can be achieved, and methane, a critical source of energy that has long been wasted from coal mines, can be conserved.

7. Investigation of Available Equipment for Directional Drilling of Coalbeds

Objective: To determine the best drilling equipment presently available for drilling directional coalbed degasification holes in a variety of geologic areas.

Control During Mining

8. Ventilation in Control of Methane

Objective: This project seeks ways of improving ventilation in coal mines, particularly in the area of new extensible face ventilation systems.

9. Gob Degasification From Underground Locations

Objective: To drain gob gas from longwall panels by drilling in overlying strata. The research products will be the technical information needed by mine operators to implement gob degasification underground. Guidelines for all phases of this work (drilling, piping, venting, and monitoring) will be presented in field demonstrations and reports of investigations.

10. Development of Control Techniques Using Horizontal Boreholes

Objective: To demonstrate that long horizontal boreholes effectively reduce methane levels during mining through natural drainage. The research products will be field demonstrations and reports of investigations of drill equipment and horizontal drilling technology.

11. Study of the Use of Water Infusion To Control Methane

Objective: To develop improvements and new techniques for the method of water infusion to reduce methane levels at the working face.

12. Application of Horizontal Drilling Technology to Health and Safety Problems in Mines

Objectives: To locate and neutralize hazardous conditions such as methane outburst zones in coalbeds, salt mines, oil shales, abandoned mine workings, and methane in strata above or below in advance of mining.

Ground Control

Program Objectives: To conceive, develop, demonstrate, and transfer technology that will prevent mine accidents attributable to falls of ground, outbursts, slope failures, and collapse of waste impoundment structures.

Premining Investigations

1. Delineation of Abandoned Mine Workings With High-Resolution Seismic Techniques

Objective: To develop high-resolution surface seismic technology for delineating the boundaries of abandoned underground mine workings. Field tests will be conducted at selected mine sites, some with known abandoned workings and others with suspected abandoned workings, to determine the optimum seismic techniques for delineating the boundaries of the workings. The test results will be verified with the known subsurface conditions, or with drilling.

2. Use of High-Resolution Resistivity System To Locate Abandoned Mine Workings

Objective: To establish operational techniques for a high-resolution resistivity measurement system in mining environments and demonstrate the effectiveness of the method for hazard detection. The detection equipment fabricated under a previous contract will be tested for locating abandoned mines near selected active mines.

3. Computerized Remote Sensing Techniques for Detection of Potential Hazards in Mine Areas

Objective: To develop and demonstrate minicomputerized methods applied to satellite imagery data for geologic anomaly detection in coal mines and other mining areas. Existing minicomputer programs will be improved and new ones developed to generate lineaments from Landsat Satellite imagery. Minicomputer facilities will be upgraded to keep up with the state of the art advances.

4. Geologic Character of Kettlebottoms and Causes of Roof Failure

Objective: To determine the geologic character and structure of kettlebottoms, their relation to mine roof problems, and the optimum manner in which they can be bolted to prevent their falling from the roof. Other types of hazardous structures will be studied to determine their relation to roof failure and to develop improved roof support techniques.

5. Guidebook for Identification of Geologic Features Contributing to Roof Falls

Objective: To prepare a handbook containing sketches and photographs of geologic structures for use by geologists and nongeologists in underground geologic mapping and prediction of areas of bad roof. This handbook will be used to identify underground geologic features that may cause unstable roof.

6. Prediction of Unstable Mine Roof Based on Remote-Sensing Analysis

Objective: To establish the relationship of linears with discontinuities in underground coal mines, and to verify and predict the association of photolinears with unstable mine roof. Linears of selected zones will be plotted, and geological discontinuities that characterize the zones will be identified.

7. Quantitative Measurement of Time Dependent Structural Behavior and Geophysical Properties of Coal Measure Rocks

Objective: To determine the time-dependent structural behavior of coal mine roof rocks in the laboratory for roof control planning and field implementation. Complete the determinations of acoustic and electromagnetic properties of rock in two bituminous coal provinces for the interpretation of field geophysical data, including the effects of stress and moisture content.

Selection of Mining System and Mine Opening Design

8. Delineation of Abandoned Mine Workings With Microwave and Synthetic Pulse Radars

Objective: To finalize an operating radar-sounding system complete with measurement equipment, data enhancement processing, displays, interpretive analysis, and three-dimensional drilling instructions. This system will detect and characterize unknown abandoned air- and water-filled mines and geological structures, such as faults controlling flooding and weak rock zones. Because of the success to date with the radar-sounding technique in locating tunnels, voids, and faults to 100-foot depths, emphasis will be on the development of a practical system for mine personnel use.

9. Mechanical Properties Handbook and Data Base

Objective: To prepare a handbook on test procedures and mechanical property data base for numerous types of rock encountered in metal and nonmetal mines. Data sets useful to mine design and ground control will be compiled from available files. This mechanical property information will be organized into a computerized numerical data base for search, retrieval, and statistical analysis.

10. Ground Control Exploration and Its Application to the Design of Underground Coal Mines

Objective: To test, evaluate, and demonstrate the Bureau's technology in mine design and site investigation in the development of new underground coal

mines; and to develop ultrasonic instrumentation capable of measuring stress changes in a mine structure and premining in situ stresses in coal mines. Assistance will be given to the coal industry in the analysis of ground control problems in new and existing coal mines. An ultrasonic rock stress measurement instrumentation based on NASA's pulse phase locked loop measurement technique will be developed.

11. Determine Validity of Existing Blasting Proximity Criteria and Vibration Scaling Law

Objective: To determine the validity of previously established damage criteria and vibration levels relative to the proximity of surface blasting operations and underground coal mine openings. The acquisition of pertinent blast vibration data from different types of mining operations from a wide range of geologic conditions will be continued in an effort to obtain a broad data base representative of the maximum variation in peak particle velocity versus scaled distance.

12. Analysis of Cutter Roof in Coal Mines Using the Finite Element Method

Objective: To demonstrate the practical applicability of the finite element method to determine the cause and predict the formation of a cutter roof failure in coal mines. The physical cause of the cutter roof failure will be hypothesized, and a two-dimensional finite element model will be formulated. It will be demonstrated analytically that a cutter roof failure can be predicted, and measured data from the mine will be used to substantiate the analytical predictions.

13. Influence of Roof and Floor Rocks on the Strength of Coal Pillars

Objective: To demonstrate the need for taking into account the properties of the roof and floor rocks when estimating pillar strength by determining the decrease of strength that occurs when coal is tested between platens made of rock, rather than of steel. This impacts on the application of test data to coal mine design, and on future testing programs that will be conducted to generate design data.

14. Ground Control Design for Room-and-Pillar and Longwall Coal Mines

Objective: To produce coal mine design manuals describing procedures that mining companies can follow, step by step, in planning new coal mines to provide safe ground control conditions. One manual will be based largely on practical experience, while the other will rely more heavily on theory. Another objective is to develop rational and practical techniques for in situ measurement and determination of ground control parameters including strata pressure, strata displacement, mining-induced load transfer, and geomechanical properties of rock masses.

15. Develop and Implement Applications Engineering Strategies for Ground Control Research

Objective: To collect and evaluate the products of research activities related to specific, real-world problems in the field of coal mine ground

control. The range of real-world problem areas where a need exists for Bureau assistance in engineering applications of research results will be defined, and the necessary strategies will be developed to insure that such assistance and research products are made available to the end users, including mine operators, equipment suppliers, MSHA, the Office of Surface Mining, and other private and public sectors. The problem areas to be dealt with immediately are longwall mining ground control related problems resulting in accidents, fatalities, and poor economic performance, and the use of rock mechanics instrumentation to aid in solving ground control problems.

16. Anchorage of Inundation Bulkheads in Coal Mine Openings

Objective: To investigate various methods of anchoring inundation bulkheads to underground coal mine openings. A review of the state of the art of inundation bulkheads and their anchorage systems will be made. A test plan will be developed to evaluate the most commonly used bulkhead-anchorage systems. The test plan will be implemented in the Bureau's Safety Research Coal Mine.

17. Classification of Mine Roof According to Support Mechanism Efficiency

Objective: To develop a systematic framework for classifying mine roof based on observed effective control techniques. A procedure for evaluating tensioned, point-anchored resin bolts will be developed, and the availability of field test sites will be assessed. The roof classification will be developed according to the roof bolt types and the characteristics of mine roofs that have been controlled in varying degrees by various support techniques.

18. Development of Guidelines for Ground Control Under Old Workings

Objective: To develop guidelines for designing and using safe and effective ground support systems when either longwall or room-and-pillar mining under old workings. An analysis will be conducted to determine stress distribution and stability characteristics of old workings, and basic rock mechanics data will be obtained. As a result, a design guidebook will be published that will list ground conditions and the safest and most effective support systems for the listed conditions.

19. Develop Improved Coal Mine Design Procedures

Objective: To further develop the practical application of the analytical techniques for planning a coal mine design by using a MINSIM-type computer program and a confined-core pillar design method; and then demonstrate their use in designing safer coal mine openings, pillars, and extraction layouts. An appropriate version of the MINSIM computer program will be selected, modified, and checked; and the confined-core pillar design method will be reviewed and incorporated into the MINSIM program. Rock physical properties will be collected from in situ and laboratory measurements and used as input data for the computer program. The analytical results will be compared with measured data of mine behavior.

20. Ground Control Design for Hard Rock Mines

Objective: To develop analytical design procedures and criteria that will reduce some of the uncertainties associated with mining systems in underground

hard rock mines. The focus will be on the interacting influence of the floor, roof, and support structures and its impact on overall mine stability. Primary emphasis will be on entry development and selection of mining systems in evaporite deposits.

21. Pillar Destressing in Advance of Mining

Objective: To demonstrate how to destress rock-burst-prone stope areas in advance of production mining. Instrumentation installation will be completed in the test block on 7900 level of the Star Mine, Idaho; and technical assistance will be given to the mine to monitor and assess a full-scale application of the destressing technique.

22. Inherently Safe Mining Method for Rock Burst Control

Objective: To provide maintenance of Bureau instruments and technical guidance to the contractor and cooperating mining company in the demonstration of underhand stoping methods under Contract No. H0292013. Areas adjoining the test stope will be instrumented to assess redistribution of stresses in other critical areas during mining.

Roof Support System

23. Inorganic Grout for Coal Mine Roofs

Objective: To develop practical systems for installing fully grouted coal mine roof bolts with fast-set inorganic cements. Material properties for the inorganic full-column roof bolt systems will be determined, and field tests will be conducted of the water microcapsule and gypsum cement cartridges in selected mines.

24. Inorganic Grouts--Materials Study

Objective: To provide a fundamental analysis of hydrocal plaster, quantify chemical and mechanical properties of the hydrocal-water capsule reaction products, and examine the special qualities and problems of the hydrocal-water capsule system for grouting roof bolts.

25. Concrete Crib Design and Field Test

Objective: To complete the field demonstrations and evaluation of concrete cribs started in FY 80 and prepare a report on the entire project. Crib load and deflection instrumentation and the physical appearance of the cribs will be monitored and recorded as the longwall excavation proceeds past the demonstration section. Load and deflection data will be compared with the results predicted by the computer finite-element model prepared during FY 79. The structural stability, performance, and economics of the concrete crib system will be analyzed and compared with those of the wood support system it replaces.

26. Comparative Laboratory Evaluation of Resin-Grouted Roof Bolt Elements

Objective: To create a complete documentation of comparative properties of all resin-grouted roof support systems, making available a means of qualitative selection of bolt types by mine personnel. Also, to provide a means of evaluating new and innovative bolt types by comparison to standard parameters determined for standard bolt types.

27. Evaluate Support Wall Systems

Objective: To determine the stability characteristics of various pack wall materials and pack systems in place. Standardized tests required to establish materials characteristics will be determined, test program guidelines will be tested to determine the overall performance ranges of a pack, and procedures will be established by laboratory and in-mine trials to evaluate pack competence. Packwalls will be tested at Mid-Continent Resources, Inc.'s #1 and #3 Mines. Laboratory tests will be performed at the Bureau's Spokane Research Center to establish in situ testing capabilities. Both laboratory and field tests of fill-in wood cribs will be conducted.

28. In-Mine Assessment of Longwall Entry Roof Support Load Characteristics

Objective: To systematically gather information on the support loadings and strata activities that take place during any of the major loading situations, and to quantify and analyze this gathered data to establish rational design criteria and support system techniques for gateroad entries. Instrumentation will be installed in the gate entries and recovery rooms of two retreating longwall mining panels. The instrumentation will be monitored starting immediately after installation and will continue until the data are unable to be collected or are considered to be no longer valuable.

29. Polymeric Sealants To Stop Shale Degradation

Objective: To conduct field evaluations and surveys using polymeric sealants to prevent shale degradation. A water-based polymeric sealant will be sprayed in two coal mines with follow-up patching and inspections. Polymeric sealants have been sprayed in two active mines in association with Contract H0272008, "Weathering Protection at the Face." These four mines will be inspected to evaluate effectiveness of the material used.

30. Modeling Roof Bolt Systems

Objective: To develop guidelines for roof reinforcement using mechanically anchored bolts, full-grouted bolts, friction stabilizers, inorganic-grouted bolts, inclined bolts, and truss systems. The field conditions best suited for each bolting system will be defined. The first series of full-scale model tests will conducted with the roof bolt test facility recently completed at the Spokane Research Center.

31. Operation and Maintenance of the Model Roof Bolt Test System

Objective: To operate and maintain the full-scale model roof bolt test system for in-house studies of roof bolting systems. The first series of full-scale tests of roof bolt systems will begin early in FY 81. In addition, some

concrete samples will be tested to determine the properties of the concrete slabs that constitute the simulated mine opening of the test facility.

32. Packwall Evaluation

Objective: To develop and characterize optimum mixture designs for support wall materials using coal and coal waste for aggregate.

33. Ground Support Systems for Block Cave Mining

Objective: To design, test, and implement better methods of support for grizzly drifts and haulage crosscuts in block cave mining, and to install, line, and backpack a haulage crosscut at the Sacaton unit of ASARCO, Inc.

34. Longhole Bolting Technique Development

Objective: To develop a new expansion shell for longhole rock bolting so as to increase anchorage capacity in stratified and massive rocks. Preliminary analyses of rock bolt parameters are in progress. Fabrication and testing of prototypes will follow to evaluate anchorage capacity and to establish bolt installation standards for rock bolting in metal and nonmetal mines.

35. Inorganic-Grouted Bolts

Objective: To develop an inorganic grout system suitable for the large bolt holes commonly drilled in metal and nonmetal mines. The initial task will be to identify reasons for poor anchorage of small-diameter bolts grouted in large-diameter holes. Pull tests will be made with different size rebar grouted in holes drilled in concrete blocks with a 1-3/8-inch drill (commonly used in metal and nonmetal mines).

36. Corrosion of Metallic Roof Support Elements

Objective To develop guidelines for MSHA to use in evaluating the effective life of an intrinsic support system, and for industry to use to improve life potential of support by utilizing corrosion prevention or control measures.

Safe Support Installation and Protection at the Face

37. Effects of Roof Bolt Installation Procedures on Mine Roof Stability

Objective: To determine the effects of initial thrust on ultimate roof stability and on the roof support system; to determine the optimum thrusts for installation of grouted bolts; and to develop reliable procedures for installation of grouted bolts to obtain maximum roof stability. A full-scale test site will be selected and instrumented. Data will be collected, reduced, analyzed, and correlated to existing information.

38. Feasibility of Aluminum Alloy Sparking Control and Prevention Measures

Objective: To quantify potential problems with using aluminum temporary roof supports, and to investigate alloy modifications or protective coatings to prevent or retard spark potential.

39. Steel Support Study

Objective: To identify the various applications and evaluate the uses of steel supports in U.S. coal mines. Data for evaluation will be compiled including identifying uses, design criteria, installation procedures, recovery techniques, accident statistics related to handling and support failure, configurations available, and cost. Guidelines will be developed for use when designing steel support systems, taking into account European experience.

40. Demonstration of a Concrete-Crib System in an Advancing Longwall

Objective: To design and demonstrate a concrete-crib support system in an advancing longwall operation. The field demonstration and evaluation of the support system will be completed, and a report will be prepared on the project.

41. Angle Bolt for Cutter Type Roof

Objective: To field-test angle bolting to determine whether it can be used to control cutter-type (shear or snap top) roof, which generally cannot be controlled by conventional bolting.

42. Automated Temporary Roof Support for Single, Fixed-Head Roof Bolting Machines

Objective: To design, fabricate, and field-test an automated temporary roof support (ATRS) that can be used with cab and/or canopy on single, fixed-head roof bolting machines. This ATRS must be set by the roof drill operator while in the operator's compartment under permanently supported roof.

43. Automated Temporary Roof Support for Continuous Mining Machines

Objective: To design, fabricate, and field-test a self-advancing automated temporary roof support (ATRS) that can be used on continuous mining machines not equipped with integral roof drills. This ATRS must turn 60° and 90° crosscuts, maintain ventilation curtain within 10 feet of the face, and be run by the continuous miner operator while in the operator's compartment.

Hazard Detection and Monitoring Systems

44. Automatic Roof Fall Warning System

Objective: To test the commercial prototype microseismic roof fall warning system in conjunction with a companion contract, modify the prototype system as necessary, and transfer the technology to the industry. The commercial prototype will be tested at several field sites. Both research-oriented and empirical experiments will be peformed in an attempt to maximize the accuracy, reliability, and usefulness of the systems.

45. Laboratory and Field Study of Roof Failure Prediction in Mines

Objective: To determine in the laboratory the causes of the time variation of phenomena precursory to fracture, e.g., microseismic noise and tilt anomalies, to enable reliable prediction of imminent roof failure in coal mines. A digital microseismic monitoring and recording system will be installed at the Galena Mine, Idaho, to develop real-time analysis capabilities. Studies of microseismic activity and elecromagnetic radiation prior to and during rock failure will continue.

46. Coal Mine Bounce and Outburst Studies

Objective: To determine if microseismic techniques can be used to delineate where and when coal mine bounces and coal and gas outbursts are going to occur, and to establish the equipment and technology required for commercial application of these techniques. In addition, failure control techniques will be tested and assessed in terms of their effectiveness. Also, to conclude and evaluate the research effort in studying the effectiveness of using thermal anomalies prior to failure as a predictive tool for coal mine bounce.

47. Develop Closure Rate Device for Roof Fall Prediction During Retreat Mining

Objective: To design and develop an intrinsically safe closure rate instrument that will provide a means of determining closure rate at any given time to alert the operator to an imminent roof fall. The instrument system will consist of rugged retrievable extensometers to be retrieved by rope or chain prior to the fall and a digital readout of the measured closure with respect to time. The system will be designed for use in retreat mining or other areas too dangerous to enter once the instrument is installed and the mining cycle has begun.

48. Detection of Coal Mine Roof Fall Hazards Utilizing Electromagnetic Sensors

Objective: To evaluate low-frequency electromagnetics and ground penetrating radar systems and modify the state of the art to develop techniques to detect potential roof falls and other hazardous conditions in underground coal mines. Existing hardware will be evaluated to determine which systems could be modified for underground use to locate and define fractures, weak strata, and anomalistic conditions that contibute to roof falls.

49. Monitoring of Under Gob and Old Working

Objective: To provide rock mechanics and mine design information, to provide monitoring for hazard detection when necessary, and to assemble and make available to industry the knowledge and techniques established through this effort. Work during this period will consist primarily of measuring ground stress physical properties and overall stability of the lower seam mining as mining progresses, and measuring reactions of the support systems to these loads and structural reactions and movements. Problem areas will be monitored for hazardous conditions using microseismic and other techniques.

50. In-Seam Seismeic Techniques for Hazard Detection From the Working Face

Objective: To establish the criteria for application of guided wave propagation for detecting hazards ahead of mining in U.S. coal seams. The effort will emphasize field verification of the theoretical basis for guided wave propagation in U.S. coal seams by conducting experiments at selected sites with known geologic conditions and representative targets of interest. Recommendations will be made for data processing, interpretation, and implementation of technology.

51. Application of Rock Burst Technology and Failure Control Methods

Objective: To assess the positive as well as negative effects of the destressing methods presently used in the Coeur d'Alene mining district, Idaho, on rock burst control in the destressed stope, and incidental structural stability problems in the adjacent stopes. The seriousness of the resulting problems will be identified, and it will be determined how a minewide microseismic monitoring system can best be used to allow mine personnel to assess their destressing program techniques on a continuing basis. Field tests will continue in the Galena Mine, and the test data will be analyzed to establish more conclusive evidence of the potential of microseismic prediction of rock bursts.

52. Prediction and Control of Rock Bursts and Failures in Mines

Objective: To develop effective and reliable methods of predicting rock bursts and controlling burst-prone stopes; to apply these methods to a mine with burst-prone stopes; and to determine criteria and procedures basic to the problem of establishing mine structure stability and how structural instabilities contribute to mine failures. Data obtained from the digital microseismic system at the Galena Mine, Idaho, will be compared with the analog system currently employed at the mine, and an effort will be made to idenify anomalous zones prior to bursts and to characterize microseismic activity from stressed and destressed material. Laboratory studies to test the inclusion theory of rock failure and further examination and documentation of electromagnetically induced discharges caused by failure of rock materials exhibiting piezoelectric effects will continue.

53. Slope Failure Detector

Objective: To field-test and improve a microseismic slope failure detection system that can be used in an open pit mine to forewarn mine management of impending slope failure so that proper safety precautions can be taken. Field monitoring will be completed at the Morenci Mine of Phelps Dodge Corp., Arizona, using the monitoring system developed by the Bureau.

54. Improved Roof-Sounding Techniques and Equipment

Objective: To establish the technology and equipment to insure improved ability to determine the condition of roof areas in freshly mined openings. To reexamine past work aimed at using dynamic techniques for measuring the soundness of roof rock in freshly mined openings. To execute new studies, using in-house equipment to determine the most promising avenues and methods to pursue. To begin execution of field studies to establish feasibility,

practicality, and reliability of measuring the dynamic response of roof rock. To establish initial data analysis procedures.

55. Guidelines for Comprehensive Rock Burst Detection Plans

Objective: To document instrumentation data from previous and ongoing rock burst studies to assist mine operators in designing comprehensive rock burst detection plans for their mines.

Mining and Minerals Processing Waste Stability

56. Evaluation of Filter Cloth for Stabilization of Coal Mine Wastes

Objective: To evaluate the criteria for selection of filter cloth to control seepage in coal mine waste dams. Laboratory tests of various filter cloths will be conducted under simulated mine waste dam environments, and preliminary guidelines for use of filter cloths in coal mine waste dams will be developed.

57. Consolidation of Coal-Clay Wastes by an Improved Flocculation Technique

Objective: To demonstrate the technical feasibility of using an improved flocculation technique to dewater waste coal sludge generated in coal preparation plants to produce a consolidated stable waste material containing 50 or more weight-percent solids that can be safely stored. Laboratory investigations will optimize flocculation and consolidation parameters and establish mass flow rates. Based on laboratory investigations, a larger scale field test unit will be designed and assembled. The feasibility of mixing dewatered coal sludge with coarse coal refuse material for long-term stabilization of both waste products also will be demonstrated.

58. Mixing Coarse and Fine Coal Wastes

Objective: To determine optimum mixing ratios of coarse and fine coal wastes to achieve maximum fill strengths for surface disposal, and to develop a method to mix and transport the mixtures while minimizing segregation. Samples of coal wastes will be obtained from preparation plants that mix fine and coarse coal wastes and that impound fine coal wastes behind an embankment of coarse wastes. Fill strengths of coarse and fine wastes will be determined by laboratory tests. A report on the waste disposal practices at the coal preparation plants visited will be prepared.

59. Alternative Coal Waste Disposal Methods

Objective: To complete physical property tests of coarse anthracite coal waste, to collect Shelby tube samples of anthracite fine waste and determine their physical properties, and to conduct laboratory model tests simulating injection of fine waste particles into voids created by coarse waste. Injection of fine waste particles into voids is aimed at increasing the support capability of backfilling and other waste disposal methods.

60. Factor of Safety-Risk Analysis in Tailings Embankments Design

Objective: To apply techniques of operations research and statistics to the design of tailing dams, establish a confidence interval or level of uncertainty about the factor of safety, investigate state of the art sampling procedures for tailings embankments, and construct simplified factor-of-safety charts for field applications and for industry's use. Sampling procedures now used to ascertain the safety of existing tailings embankments will be investigated, and a statistical procedure to be applied to on-site embankment maintenance and control will be developed.

Industrial-Type Hazards

Program Objectives: To (1) limit the possibility of human error through training and worker-machine interfacing, (2) improve equipment design and controls, (3) detect and prevent failures of electric circuitry and hardware, (4) provide adequate lighting in working areas, (5) insure continuous and reliable communication between all underground and surface mine personnel, while providing continuous surveillance of the mine environment, and (6) improve safety in haulage and materials-handling operations.

Human Factors

1. Surface Mining Training

Objective: To develop information and strategies to aid mining companies and MSHA in implementing and monitoring effective training programs. A report entitled "Training Evaluation for the Minerals Industry: A Literature Survey" will be completed.

2. Human Factors and Industrial Safety

Objective: To investigate and develop new human-factors-related programs and to support ongoing contract efforts in this area. The shuttle car and continuous miner training system will be evaluated with respect to future work station and control-display design research.

Electrical

3. Electrical Ignition Hazards

Objective: To investigate research problems related to intrinsic safety and explosion-proof enclosures. Technical support to Bureau programs and MSHA, and cooperation with national and international committees engaged in developing standards for the use of electrical equipment in potentially explosive atmospheres will be provided.

4. Electrical Equipment, Devices, and Systems

Objective: To conduct preliminary investigations and final evaluations relating to contracted research and design tasks in the field of mine electrical systems and devices. Technical assistance will be provided to MSHA and the mining industry.

5. Handbook for Electrical Grounding Safety for Small Pits and Quarries

Objective: To develop a comprehensive handbook for field use concerning grounding practices for the small surface operator. Proper grounding procedures will be identified and presented in an easy-to-understand, "how to" format for use by operators of small pits and quarries.

Equipment

6. Participation on Society of Automotive Engineers (SAE) Technical Committee on Mining Equipment

Objective: To allow Bureau personnel to actively participate on the SAE Technical Committee on Mining Equipment. The committee develops standards that cover requirements for safeguarding life and property on underground and surface mining equipment.

7. Equipment Development

Objective: To continue evaluation of brakes and development of safe rerailing techniques. Investigation of antireverse motor locks and evaluation and development of low-speed measurement technology will also be undertaken.

8. Machinery-Maintenance-Related Accidents--Evaluation of Existing Data

Objective: To determine and quantify the specific hazards and reasons for maintenance and repair-related accidents in the coal mining industry. In close cooperation with MSHA, industry, and MSHA's Health and Safety Analysis Center, accident data will be collected and analyzed. Identified mitigatible health and safety problems will be categorized and ranked on a research priority basis.

9. Field Testing and Evaluating a New Improved Seat and Seat Belt System for Surface Mining Equipment

Objective: To evaluate operator acceptance of improved seat belt systems developed under contract by the Bureau. The new systems will be installed and tested in-mine with operator acceptance being monitored by observations and interviews.

10. Evaluation of Cracklike Discontinuities of Rollover Protective Structures

Objective: To define and characterize the service life of ROPS on surface mining equipment. Cracks in the welds and materials used in ROPS will be analyzed to determine the cause of these types of failures.

11. Collision Protection Systems for Large Mobile Mining Equipment

Objective: To develop and in-mine test prototype systems to reduce the vehicle collision hazard in surface mines. As vehicle size increases, reduced driver field of vision increases the collision danger. Ruggedized, reasonably priced prototype hardware will be developed to reduce this hazard.

Illumination

12. Mine Illumination

Objective: To investigate the illumination of surface mining equipment. Specialized power supplies will be evaluated and a computer-based system to photometrically evaluate mine illumination hardware will be developed. Technical assistance will be provided to MSHA and the mining industry.

13. Recommendations for Minimal Luminance Requirements for Metal and Nonmetal Mines

Objective: To define minimum luminance requirements for various job tasks and work areas in metal and nonmetal underground mines. The purpose is to provide overview information and supportive data for the formulation of illumination standards.

Nonemergency Communications

14. Mine Telemetry and Environmental Surveillance Systems

Objective: To design, procure, laboratory-test, and in-mine evaluate an intrinsically safe mine monitoring system. Performance levels of the total system will be established and analyzed.

15. Performance Standards and Systems Approach to Mine Monitoring

Objective: To conduct preliminary investigations and maintain a base of knowledge in the areas of mine monitoring system safety, evaluation, equipment design, and equipment performance evaluation. Work will concentrate in the areas of equipment reliability, data transmission security, sensor evaluation, and safety evaluation.

16. Underground Communication Systems

Objective: To develop and field-evaluate special systems and hardware for the purpose of improving underground communications, monitoring, and control. Systems based on new technologies such as fiber optics, short-range VHF, and microwaves will be investigated. Basic measurements on phone lines and free space propagation will be conducted to expand baseline data in these areas, and assistance will be given to the mining industry in solving any specific communication problems.

17. Development of Head-Worn Coal Face Communication Systems

Objective: To develop a head-worn communications system that is integrated into a miner's hat. The device will address the problem of the loss of cap-lamp signaling ability in illuminated low-coal environments. Existing head-worn communication systems that were designed for other industrial applications will be redesigned and integrated into an approved miner's hat.

18. Communications Equipment for Sunshine Mine

Objective: To purchase communications equipment and associated items in support of the ongoing demonstration of communication, telemetry, and monitoring systems at the Sunshine Mine.

19. Communications Equipment for Black River Mine

Objective: To purchase communications and monitoring and fire detection equipment in support of the ongoing demonstration of communication, telemetry, and monitoring systems at the Black River Mine.

Haulage and Materials Handling

20. Laboratory Analysis of Wire Rope

Objective: To define characteristics of wire rope that affect rope degradation during use in mine hoisting. Mechanisms of wire rope failure will be determined by monitoring rope through field use and by laboratory analysis of retired rope specimens.

21. Fatigue Testing of Wire Rope

Objective: To conduct fatigue tests that can be used as a basis for wire rope retirement criteria. Fatigue tests will be conducted on wire rope to determine rope life at different loads and to determine when appropriate safety factors have been met. Recommendations on retirement criteria will be made on the basis of the fatigue tests. Data will be used to improve retirement criteria standards, aid users in proper rope selection, and aid MSHA safety regulation.

22. Materials-Handling Equipment Development

Objective: Investigate methods by which various facets of materials-handling activities can be made less human-labor intensive. Particular areas of interest would be the transfer and handling of machine components during maintenance activities, the handling of fall debris, and research in support of contractual efforts in this area. This effort will design and construct prototype devices to minimize the human handling of underground supplies. The devices will be evaluated in operating mines.

23. Shaft Maintenance Guidelines

Objective: To identify the hazards associated with shaft and slope repair and maintenance. Maintenance and repair procedures will be reviewed, and guidelines will be prepared that will improve safety.

24. Surface Mine Equipment Safety

Objective: To develop and demonstrate new mobile mine vehicle safety hardware in the areas of vehicle towing, driver alertness, and operator ingress and egress systems.

25. Laboratory Analysis of Wire Rope

Objective: To define characteristics of wire rope and its use that affect its service life. New and retired rope specimens will be analyzed, and rope usage in the field will be monitored. Manufacturing procedures, wire rope materials, and in-service procedures that have potential for improving the performance and safety of wire rope used in mining will be defined.

Post Disaster

Program Objectives: To develop technology that will (1) enable survivors of a mine disaster to escape from the mine or to continue to survive while awaiting rescue by providing protection against toxic and/or oxygen-deficient atmospheres, (2) aid in the location of miners trapped underground, using seismic and electromagnetic means of communication, and (3) facilitate post disaster rescue and recovery operations through surface monitoring of conditions underground, emergency communications, and mechanized transport and life-support equipment for mine reentry and rescue operations.

Survival

1. Development of Life Support Technology

Objective: To investigate, evaluate, and further develop advanced life-support technology for use in coal mines for self-rescue and rescue team operations. Specific products include a prototype rescue apparatus, several reports useful to MSHA and industry in developing escape standards, and evaluations of new oxygen self-rescuers and rescue breathing apparatus.

2. Improved Oxygen Sources for Breathing Apparatus

Objective: To develop solid chemicals that provide more oxygen per unit weight than the potassium superoxide presently used in self-contained breathing apparatus.

Communications

3. Trapped Miner Location and Communication

Objective: To develop emergency detection and location systems for post disaster rescue efforts, evaluate hardware for same, and provide technical assistance to contractors conducting field test programs.

4. Development of Trapped Miner Location System Using Phase Difference of Arrival Techniques

Objective: To determine the feasibility of using "phase difference of arrival concepts" (PDOAC) to develop an electronic system for locating trapped miners. The use of PDOAC to make a three-dimensional estimate of the location of a miner trapped below the earth's surface should greatly improve present technology for such measurements.

5. Short-Range Location

Objective: To develop an EM transmitter device that can be incorporated into a miner's lamp battery and/or a passive device that can be activated remotely that will enable rescuers within a 20- to 30-meter radius to accurately locate the source of transmission.

Explosives

Program Objectives: To assess the problems associated with the safe and effective use of explosives in all types of mining activity; these include fixed explosives, blasting agents, blasting devices, and blasting accessories. To conduct fundamental studies of explosive behavior and apply the results in the development of new technology. To develop new and improved test procedures as new mining methods are introduced and new types of explosives are formulated.

Blasting Agents and Other Hazardous Chemicals

1. Permissible Exposive Evaluation and Research

Objective: To explore and resolve problems associated with safe and effective use of underground coal mine explosives in gassy and dusty mines. The research program will include a study of the causes of misfires and deflagrations occasionally reported for permissible water gels. New formulations prepared by other Bureau personnel will be tested in the gallery; this supportive work is part of an effort to control the incendivity of water gels with chemical additives. Work will include testing new permissibles, field samples, and explosives involved in mine incidents.

2. Development of New Schedule Tests and Standards

Objective: To develop standards for permissible explosives, explosive devices, and blasting accessories, and to develop test procedures and basic knowledge of explosive incendivity in support of the standards. Schedules and related tests will be developed for stemming devices and other explosive-actuated devices. The problems of desensitization of water gel explosives by extreme temperatures and dynamic desensitization leading to misfires will be investigated. In addition, the mechanisms of ignition of flammable atmospheres by shot firing will be investigated.

3. Hazards of Explosives and Explosive Devices

Objective: To produce data, supply information, and make recommendations relating to the sensitivity of explosives and initiating devices to impact, friction, thermal, and electrostatic stimuli. Optimum designs for antielectrostatic devices for electric detonators will be developed. Research for an ultrasafe detonator will continue, applying results of antielectrostatic studies and incendivity studies from related projects. Sensitivity tests will be conducted in connection with investigations of misfire accidents.

4. Fire Hazards of Explosives and Blasting Agents

Objective: To produce data in support of the development of standards for the storage and handling of explosives and blasting agents. Large-scale (field) burning tests of explosives and blasting agents will be conducted, based on information gathered from laboratory experiments. Laboratory-scale determinations of ignitibility, burning rate, sensitization at elevated temperatures, and tendency to detonate during combustion will be continued for these explosives. Laboratory and field test results will be correlated, in order to provide a set of test procedures and standards for determining tendency to detonate.

5. Development of New Explosive Systems

Objective: To develop safer and more efficient explosives for the mining industry, evaluate basic sensitization processes in water gel explosives and blasting agents, and examine the effects of chemical species and degree of confinement on incendivity of permissible explosives.

6. Analysis of Mine Blasting Accidents

Objective: To analyze mine and construction blasting accidents and incidents to insure that the Bureau research effort is directed toward the real causes of blasting accidents.

7. Prepare a Practical Blasting Handbook

Objective: To prepare a practical blasting handbook to meet the needs of industry and Government agencies.

Systems Engineering

Program Objectives: To develop mathematical models for evaluating the impact of specific technological improvements or inadequacies on the total mining and minerals processing operations and identifying problems whose solution would provide the greatest health and safety benefit. To operate and maintain underground research and test facilities for use in testing and demonstrating new procedures and equipment, before they are field-tested in commercial mines. To participate in contract development and in the formulation of mining and minerals processing health and safety standards.

Systems Analysis

1. Planned Application of Research Results to Mining Operations

Objective: To examine, select, process, and package pertinent Bureau research results related to coal mine safety, efficiency, and conservation in order to effectively integrate them into the total mining system. Also, to identify technology gaps in research and to improve techniques of planning, designing, and operating underground coal mines.

2. Establish Mine Vehicle Environmental Parameters for Component Specification Requirements

Objective: To qualify and quantify mine vehicle environmental parameters so that realistic design specifications for mine vehicle components can be developed.

3. Statistical Accident Analysis and Literature Research

Objective: To define patterns in mining accidents by applying appropriate statistical analysis techniques to Health Safety Analysis Center (MSHA) mining accident data. To establish ways of reviewing, organizing, and summarizing past research with intent to apply it to current industry problems.

4. Economics of the Application of Improved Health and Safety Hardware

Objective: To determine the cost effectiveness of specific Bureau-developed safety devices.

Test Facilities

5. Operation of the Experimental Mine and Safety Research Coal Mine

Objective: To maintain and operate the two mine facilities at Bruceton, Pa., that are used for coal mine health and safety research problems. The underground mines must be maintained in safe and proper operating condition in order to conduct full-scale experiments on explosives, dust suppression, roof control, ventilation, fire and explosion prevention and suppression, haulage safety, communications, mines surveillance, and related facets of coal mine health and safety research.

6. Operation of the Lake Lynn Experimental Test Facility

Objective: To maintain and operate the Bureau's new full-scale underground multiple-entry facility and evaluate the effectiveness of various techniques developed for extinguishing coal dust explosions. Included in the testing are extinguishment hardware, ignition quenching devices, and passive and triggered barriers. These studies provide information on the velocity and length of flames, the velocity and pressure waves in advance of flame front, composition of gases at various stages of explosions, and other physical and chemical phenomena associated with gas and coal dust explosions.

☆U.S. GOVERNMENT PRINTING OFFICE: 1981-703-002/09 INT.-BU.OF MINES,PGH.,PA. 25316

280
PD 1.46

DOBBS BROS.
LIBRARY BINDING
JUN 81
ST. AUGUSTINE
FLA.
32084

LIBRARY OF CONGRESS
0 002 959 970 1